APPENDIX A

DR. PHILIP C. D. HOBBS

PROFESSIONAL EXPERIENCE

ELECTROOPTICAL INNOVATIONS LLC/ HOBBS ELECTROOPTICS, Briarcliff Manor, NY
2009- Present

Principal
Established a consultancy in electro-optical system design and debug; IP litigation; and proprietary product design for licensing; much more detail at http://electrooptical.net

- Design of new instrument and measurement technologies for proprietary products.
- Design consultant in medical devices, semiconductor processing and inspection equipment, pollution sensing, ultrasensitive amplifiers, spectrometers, single-pixel cameras, displays, ultrastable lasers, geophysical instruments, tactical communications, vacuum instruments, agricultural product grading, and spectroscopic remote sensing. Designed a line of advanced photonic instruments for Hobbs ElectroOptics and advanced photoreceivers, biochip front ends, and numerous proof-of-concept instruments for clients.
- Testifying expert witness in 17 patent and trade secret suits or reexaminations, for both defendants and plaintiffs: testified in a $100M suit in 2015; deposed in invalidity, noninfringement, and claim construction; wrote several declarations and expert reports; found additional prior art, produced detailed technical arguments and performed extensive reverse-engineering; served as a neutral expert referee in an IP dispute between former JDA partners.
- Published the second edition of *Building Electro-Optical Systems: Making It All Work.*

IBM THOMAS J WATSON RESEARCH CENTER, Yorktown Heights, NY **1987 – 2009**

Research Staff Member, Advanced Optical Interconnection 2002 – 2009

- Invented a new silicon photonic interconnect technology for servers, based on MIM tunnel junctions coupled to on-chip optical waveguides via plasmonic metal antennas
- Demonstrated technologically-useful overall efficiencies (7%), an improvement of more than 50 times over any previous antenna-coupled tunnel junction device
- Developed process recipes and wrote runsheets for fabricating SOI waveguides and MIM antennas
- In 2007-09, helped set IBM's OI direction as a member of the Optical Interconnection Strategy team, including build/buy decisions in multichannel multimode transceivers, mostly in modified MT ferrules
- Invented several alignment technologies for inter-chip optical links, for manufacturability and yield
- Invented a novel immersion solar concentrator system and an all-passive two-axis servo system for ultrahigh performance solar photovoltaic concentrators (2300 suns). Co-PI on a NSF GOALI program to make ultrasensitive bioassay sensors. Visiting Scientist at CU/JILA and MSU. Built two special sensors that successfully solved production stoppages in IBM Z-Series servers
- Wrote POEMS (Programmable Optimizing Electromagnetic Simulator), a full 3D multi-CPU code that runs both on Linux clusters and on ordinary Windows PCs, to support the Si photonics work.

Research Staff Member, Computer Science 1998 – 2001

- Invented Footprints, a tiled network of ultralow cost, high performance thermal imagers to track people's movements in large indoor spaces, and led a 5-person team that took it from concept through successful pilot in a large department store. The 96-pixel sensors used screen-printed pixels on PVDF film, with a single LED per pixel used as a readout switch. Each 96-pixel sensor cost $50 complete, and achieved a NEΔT of 0.13 K, a creditable figure even for sensors costing 100 times more.
- Wrote "*Building Electro-Optical Systems: Making it All Work*".

Research Staff Member, Manufacturing Research 1989 – 1998

- Developed many ground-breaking spectroscopic, lidar, and radioassay instruments for use in semiconductor and disk drive manufacturing lines. Technical details for some of these appear at http://electrooptical.net. They include the *In-Situ* Coherent Lidar (ISICL) sensor, which achieved quantum-limited sensitivity despite background light over 10^8 times brighter than the signal; Colorimetric chemical sensors for metal ions that achieved parts-per-billion sensitivity; The whole

field of laser noise cancellation, allowing quantum-limited measurements with lasers up to 10^7 times noisier; *e.g*. tunable diode laser absorption spectroscopy at 1 part in 10^7; Current-tuned compound raster scanning, a method for improving mechanical laser scanner performance by 10-50 times.

- Co-invented solid immersion microscopy and built the first silicon-lens solid immersion microscope prototype; developed the first closed-loop control system for lithographic line width (for 16M DRAM); designed and prototyped improved overlay alignment sensors subsequently retrofitted to 35 Perkin Elmer Censor wafer steppers, allowing one more bipolar logic generation (IBM ATX-4) to use G-line lithography (visible) instead of I-line (UV). This saved a $125M equipment purchase.
- Invented an etalon system for simultaneous laser stabilization and intracavity measurements at the quantum limit. Invented low cost ($10) head tracker for computer input, requiring no headgear.

Post-Doctoral Scientist 1987 – 1989

- Designed and prototyped the first commercial atomic and magnetic force microscope-the IBM SXM, also the first to work with 8-inch wafers, and used it to set the world's record for magnetic force resolution. A version of this microscope was still in production 25 years later. Also invented the first particle-free corona point air ionizer for semiconductors.

EDUCATION

PhD, Applied Physics, Stanford University, 1987

B. Sc., Astronomy & Physics, Honors, University of British Columbia, 1981

SELECTED AWARDS AND RECOGNITION

IBM Outstanding Technical Achievement Award; IBM Research Division Award; IBM Master Inventor; R&D 100 Award; Photonics Spectra Commercial Technology Award

SELECTED PUBLICATIONS

- Philip C. D. Hobbs, Building Electro-Optical Systems: Making It All Work, Second Edition, Wiley-Interscience, New York, 2009.
- Philip C. D. Hobbs, "Ultrasensitive Laser Measurements Without Tears", *Applied Optics* **36**, 4, pp 903-920 (1 February 1997). (Optics InfoBase citation)
- Philip C. D. Hobbs, Robert B. Laibowitz, Frank R. Libsch, Nancy C. LaBianca, and Punit P. Chiniwalla, "Efficient waveguide-integrated tunnel junction detectors at 1.6μm", *Optics Express* **15**, 25 pp. 16376-16389 (December 10, 2007). (Optics InfoBase citation)
- Philip C. D. Hobbs, Robert B. Laibowitz, & Frank R. Libsch, "Ni-NiO-Ni Tunnel Junctions for Terahertz and Infrared Detection ", *Appl. Opt.* **44**, 32, 6813-6822 (2005). (Optics InfoBase citation)
- P. C. D. Hobbs, "ISICL: In-Situ Coherent Lidar for detecting particles in semiconductor processing chambers", *Applied Optics* **34**, 9, March 20, 1995. (Optics InfoBase citation)
- Philip C. D. Hobbs, "Reaching the shot noise limit for $10", *Optics and Photonics News* **2**, 4 17-23 (April 1991). (Optics InfoBase citation)
- Philip C. D. Hobbs, "Photodiode Front Ends: The Real Story", *Optics & Photonics News* **12**, 4, pp 44-47, (April 2001). (Optics InfoBase citation)
- P. C. D. Hobbs, D. W. Abraham, and H. K. Wickramasinghe, "Magnetic force microscopy with 25 nanometer resolution", *App. Phys. Lett.* **55**, 22, pp. 2357-9 (1989)
- Philip C. D. Hobbs, "A $10 Thermal Infrared Imager", *Proc. SPIE* **4563**, p. 42-51, Sensors and Controls for Intelligent Manufacturing II, Peter E. Orban; Ed. (2002).
- Philip C. D. Hobbs, "Footprints: A 'War Story'", *Optics & Photonics News* **14**, 9, p. 32-37, September 2003.
- Philip C. D. Hobbs, "POEMS: A Programmable Optimizing Electromagnetic Simulator", http://electrooptical.net/www/poems/poemsmanual.pdf

U. S. PATENTS

Solar Photovoltaics

- US08569616: Method of concentrating solar energy
  US08026439: Solar concentrator system

Quantum Computing

- US07889992: Hybrid Superconductor Optical Repeater

Optical Interconnection

- US08528805: Method and apparatus providing fine alignment of a structure
- US08104468B2: Method and apparatus providing fine alignment of a structure relative to a support
- US07857195B2: Method and apparatus providing fine alignment of a structure relative to a support
- US07841510: Method and apparatus providing fine alignment of a structure relative to a support
- US20080310808A1: Photonic waveguide structure with planarized sidewall cladding.
- US20080180340A1: Waveguide coupling devices
- US07542643B2: Waveguide alignment using waveguide fiducials
- US07480429: Chip to chip optical interconnect
- US07421160: Coupling element using waveguide fiducials
- US07412134: Apparatus and methods for remakeable connections to optical waveguides
- US07197207 Apparatus and method for optical interconnection
- US07116865: Apparatus and methods for remakeable connections to optical waveguides
- US06983097: Magneto-optical switching backplane for processor interconnect
- US06816637: Magneto-optical switching backplane for processor interconnect

Footprints: A Network of Distributed Low-Cost Infrared Imagers

- US06614348: System and method for monitoring behavior patterns
- US06449382: A method and system for recapturing a trajectory of an object
- US06399946: Pyroelectric film sensors

Ultrasensitive Measurements

- US05134276: Noise cancelling circuitry for optical systems …
- US06259712: Interferometer method for providing stability of a laser
- US05648268: Radionuclide exchange detection of ultra trace ionic impurities...
- US05294806: Optical submicron aerosol particle detector
- US05204631: System and method for automatic thresholding of signals in Gaussian noise
- US05192870: Optical submicron aerosol particle detector
- US05133602: Particle path determination system

Instruments for Manufacturing and Process Control

- US06567172: System and multipass probe for optical interference measurements
- US05691540: Assembly for measuring a trench depth parameter of a workpiece
- US05516608: Method for controlling a line dimension arising in a photolithographic process
- US05432670: Generation of ionized air for semiconductor chips
- US05343290: Surface particle detection using heterodyne interferometer
- US05316970: Generation of ionized air for semiconductor chips
- US05116583: Suppression of particle generation in a modified clean room air...

Advanced Scanning Technology

- US06118518: Assembly comprising a pocket 3-d scanner
- US06057947: Enhanced raster scanning assembly
- US05986759: Optical interferometer measurement apparatus and method
- US05908586: Method for addressing wavefront aberrations in an optical system
- US05794023: Apparatus utilizing a variably diffractive radiation element
- US05638176: Inexpensive interferometric eye tracking system

Solid-Immersion Microscopy (NA=2.8 to 3.2)

- US05220403: Apparatus and a method for high numerical aperture microscopic examination of materials
- US05208648: Apparatus and a method for high numerical aperture microscopic examination of materials

Scanned-Probe Microscopy

- US05298975: Combined scanning force microscope and optical metrology tool